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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	PERFORMANCE MODELING OF COMMUNICATION NETWORK
COURSE CODE	:	BWB 43703
PROGRAMME	:	4 BWQ
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

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Q1 Please answer **T (True)** or **F (False)**.

(a) A system is a collection of interrelated components that function together to achieve some outcome.
(b) A numerical description of the outcome of an experiment is called a random variable.
(c) A distributed system is one in which the components of an information system are distributed across multiple locations and computer networks.
(d) OSI model consists of eight layers.
(e) Data Communication deals with the transmission of signals in a reliable and efficient manner.
(f) In queuing theory TEN accesses can be done at once.
(g) Data Communication system is made up of seven basic components.
(h) Statistics does not help us to quantify.
(i) Important parameters has to be controlled while conducting experiments.
(j) A network is not a connected system of objects or people.

(10 marks)

Q2 List and explain **TEN (10)** Systematic Approach in Performance Modeling of Communication Network.

(10 marks)

Q3 There are various techniques for workload characterization. One of them is Clustering. List and explain all ten clustering steps.

(10 marks)

Q4 Suppose that a queuing system has two servers, an exponential inter arrival time distribution with a mean of 2 hours and an exponential service-time distribution with mean of 2 hours for each server. Furthermore, a customer has just arrived at 12:00 noon.

(a) What is the probability that the next arrival will come

(i) before 1:00 p.m,
(ii) between 1:00 and 2:00 p.m,
(iii) after 2:00 p.m.?

(3 marks)

(b) Suppose that no additional customers arrive before 1:00 p.m. What is the probability that the next arrival will come between 1:00 and 2:00 p.m?

(2 marks)

(c) What is the probability that the number of arrivals between 1:00 and 2:00 p.m. will be

(i) zero,
(ii) one,

(iii) two or more?

(2 marks)

(d) Suppose that both servers are serving customers at 1:00 p.m. What is the probability that neither customer will have service completed before

(i) 2:00 p.m.,
(ii) 1:10 p.m.,
(iii) 1:01 p.m.?

(3 marks)

Q5 A queuing system has two servers whose service times are independent random variables. Both servers have an exponential distribution with a mean of 15 minutes. Customer X arrives when both servers are idle. Five minutes later, customer Y arrives and customer X is still being served. Another 10 minutes later, customer Z arrives and both customers X and Y are still being served. No other customers arrived during this 15 minutes interval. What is the probability that

(a) customer X will complete service before customer Y?

(3 marks)

(b) customer Z will complete service before customer X?

(5 marks)

(c) customer Z will complete service before customer Y?

(2 marks)

Q6 A computer system can operate in two different modes. Every hour, it remains in the same mode or switches to a different mode according to the transition probability matrix;

$$P = \begin{bmatrix} 0.4 & 0.6 \\ 0.6 & 0.4 \end{bmatrix}$$

(a) Compute the two-step transition probability matrix.

(5 marks)

(b) If the system is in mode 1 at 5:30 p.m., what is the probability that it will be in mode 1 at 8:30 p.m. on the same day?

(5 marks)

Q7 A computer device can be either in a busy mode (state 1) processing a task, or in an idle mode (state 2), when there are no tasks to process. Being in a busy mode, it can finish a task and enter an idle mode any minute with the probability 0.2. Thus, with the probability 0.8 it stays another minute in a busy mode. Being in an idle mode, it receives a new task any minute with the probability 0.1 and enters a busy mode. Thus, it stays another minute in an idle mode with the probability 0.9. The initial state is idle. Let X_n be the state of the device after n minutes. Find

(a) the distribution of X_2,

(5 marks)

(b) the steady-state distribution of X_n.

(5 marks)

Q8 Consider a system with two components. We observe the state of the system every hour. A given component operating at time n has probability p of failing before the next observation at time $n + 1$. A component that was in a failed condition at time n has a probability r of being repaired by time $n + 1$, independent of how long the component has been in a failed state. The component failures and repairs are mutually independent events. Let X_n be the number of components in operation at time n. The process $\{X_n, n = 0, 1, \ldots\}$ is a discrete time homogeneous Markov chain with state space $1 = 0, 1, 2$.

(a) Determine its transition probability matrix and draw the state diagram.

(5 marks)

(b) Obtain the steady state probability vector, if it exists.

(5 marks)

Q9 Consider a game of "ladder climbing". There are five levels in the game, level one is the lowest (bottom) and level five is the highest (top). A player starts at the bottom. Each time, a fair coin is tossed. If it turns up heads, the player moves up one run. If tails, the player moves down to the very bottom. Once at the top level, the player moves to the very bottom if a tail turns up, and stays at the top if head turns up. Find the

(a) transition probability matrix,

(2 marks)

(b) two-steps transition probability matrix,

(3 marks)

(c) steady-state distribution of the Markov chain.

(5 marks)

Q10 What advantage does a circuit-switched network have over a packet-switched network? Why is it said that packet switching employs statistical multiplexing? Contrast statistical multiplexing with the multiplexing that takes place in Time-division Multiplexing (TDM).

(10 marks)

-END OF QUESTION-